

# Operating instructions

## **VARIO - PLANETARY MILL**

### **PULVERISETTE 4**

Valid starting with: 04.1030/0139



**Read the instructions prior to performing any task!**

---

Translation of the original operating instructions

Fritsch GmbH  
Milling and Sizing  
Industriestraße 8  
D - 55743 Idar-Oberstein  
Telephone: +49 (0)6784/ 70-0  
Fax: +49 (0)6784/ 70-11  
Email: [info@fritsch.de](mailto:info@fritsch.de)  
Internet: [www.fritsch.de](http://www.fritsch.de)

## Certifications and CE conformity

### Certification

Fritsch GmbH has been certified by the TÜV-Zertifizierungsgemeinschaft e.V.



An audit certified that Fritsch GmbH conforms to the requirements of the DIN EN ISO 9001:2008.

### CE Conformity

The enclosed Conformity Declaration lists the guidelines the FRITSCH instrument conforms to, to be able to bear the CE mark.



## Table of contents

<b>1</b>	<b>Basic structure.....</b>	<b>7</b>
<b>2</b>	<b>Safety information and use.....</b>	<b>8</b>
2.1	Requirements for the user.....	8
2.2	Scope of application.....	8
2.2.1	Operating principle.....	9
2.3	Obligations of the operator.....	9
2.4	Information on hazards and symbols used in this manual. .	10
2.5	Device safety information.....	13
2.6	Protective equipment.....	14
2.6.1	Opening the hood without mains connection.....	14
2.7	Hazardous points.....	14
2.8	Electrical safety.....	15
2.8.1	General information.....	15
2.8.2	Protection against restart.....	15
2.8.3	Overload protection.....	15
<b>3</b>	<b>Technical data.....</b>	<b>16</b>
3.1	Dimensions.....	16
3.2	Weight.....	16
3.3	Operating noise.....	16
3.4	Voltage.....	16
3.5	Current consumption.....	16
3.6	Power consumption.....	16
3.7	Electrical fuses.....	16
3.8	Material.....	17
3.9	Final fineness.....	17
<b>4</b>	<b>Installation.....</b>	<b>18</b>
4.1	Transport.....	18
4.2	Unpacking.....	18
4.3	Setting up.....	19
4.4	Ambient conditions.....	21
4.5	Electrical connection.....	21
4.6	Connecting the computer.....	22
4.7	Adjusting the mains voltage.....	22
4.8	Detection of the direction of rotation.....	22
<b>5</b>	<b>Initial start-up.....</b>	<b>23</b>
5.1	Switching on.....	23
5.2	Function check.....	23
5.3	Switching off.....	23
<b>6</b>	<b>Using the device.....</b>	<b>24</b>
6.1	Choice of grinding bowls and grinding balls.....	24

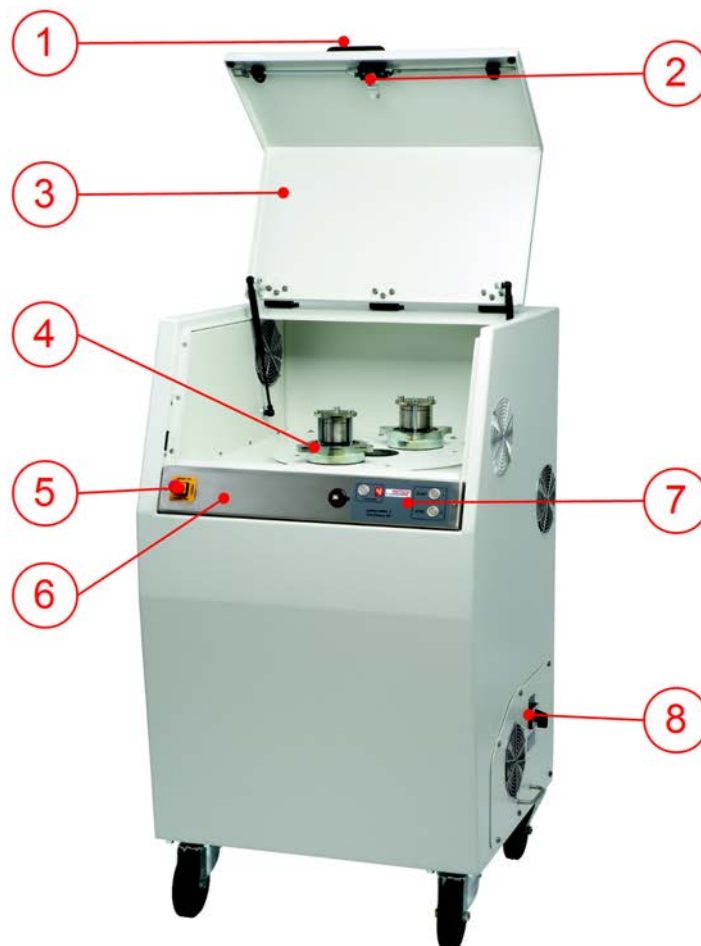
## Table of contents

6.1.1	Size of the grinding balls.....	26
6.1.2	Number of balls per grinding bowl (independent of the material quantity).....	27
6.1.3	Calculated weight of a ball.....	28
6.2	Filling quantities of grinding bowls.....	28
6.3	Filling the grinding bowl.....	29
6.4	Factors with an impact on grinding.....	29
6.4.1	Running time (grinding duration).....	29
6.4.2	Speed.....	29
6.4.3	Reverse mode.....	30
6.4.4	Number and size of the balls.....	30
6.4.5	Weight of the balls (type of material).....	30
6.4.6	Dry grinding.....	30
6.4.7	Wet grinding (grinding in a suspension).....	31
6.5	Clamping the grinding bowls.....	31
6.5.1	Clamping the 500 ml, 250 ml and 80 ml grinding bowls...	32
6.5.2	Clamping the 45 ml and 12 ml grinding bowls.....	33
6.6	Mass balance.....	34
6.7	Grinding duration.....	35
6.8	Settings on the control panel.....	36
6.8.1	Select program.....	36
6.8.2	Start the mill.....	36
6.8.3	Switching off.....	36
6.8.4	Meaning of the LED display.....	36
6.9	Conducting a grinding operation.....	37
6.9.1	Overload.....	37
6.9.2	Interrupt a grinding process.....	37
6.9.3	Switching off.....	38
6.10	Cooling the grinding bowl.....	38
<b>7</b>	<b>Accessories.....</b>	<b>39</b>
7.1	Additional clamping system for grinding harmful substances or in a gas atmosphere.....	39
7.1.1	Locking the additional clamping system into place.....	39
7.1.2	Grinding in inert gas with gassing lid.....	41
7.2	GTM - system.....	44
<b>8</b>	<b>Cleaning.....</b>	<b>45</b>
8.1	Grinding elements.....	45
8.2	Mill.....	45
<b>9</b>	<b>Maintenance.....</b>	<b>46</b>
<b>10</b>	<b>Repairs.....</b>	<b>47</b>
<b>11</b>	<b>Examples of comminution tasks.....</b>	<b>49</b>
<b>12</b>	<b>Disposal.....</b>	<b>51</b>

## Table of contents

13	Guarantee terms.....	52
14	Exclusion of liability.....	54
15	Safety logbook.....	56
16	Index.....	58

## 1 Basic structure



- 1 Hood handle
- 2 Hood lock
- 3 Hood
- 4 Grinding bowl holder

- 5 Emergency stop switch
- 6 RS232 interface
- 7 Control panel
- 8 Main switch

## **2 Safety information and use**

### **2.1 Requirements for the user**

This operating manual is intended for persons assigned with operating and monitoring the Fritsch PULVERISETTE 4. The operating manual and especially its safety instructions are to be observed by all persons working on or with this device. In addition, the applicable rules and regulations for accident prevention at the installation site are to be observed. Always keep the operating manual at the installation site of the PULVERISETTE 4.

People with health problems or under the influence of medication, drugs, alcohol or exhaustion must not operate this device.

The PULVERISETTE 4 may only be operated by authorised persons and serviced or repaired by trained specialists. All commissioning, maintenance and repair work may only be carried out by technically qualified personnel. Qualified personnel are persons who, because of their education, experience and training as well as their knowledge of relevant standards, regulations, accident prevention guidelines and operating conditions, are authorised by those responsible for the safety of the machine to carry out the required work and are able to recognize and avoid possible hazards as defined for skilled workers in IEC 364.

In order to prevent hazards to users, follow the instructions in this manual.

Malfunctions that impair the safety of persons, the PULVERISETTE 4 or other material property must be rectified immediately. The following information serves both the personal safety of operating personnel as well as the safety of the products described and any devices connected to them: All maintenance and repair work may only be performed by technically qualified personnel.

This operating manual is not a complete technical description. Only the details required for operation and maintaining usability are described.

Fritsch has prepared and reviewed this operating manual with the greatest care. However, no guarantee is made for its completeness or accuracy.

Subject to technical modifications.

### **2.2 Scope of application**

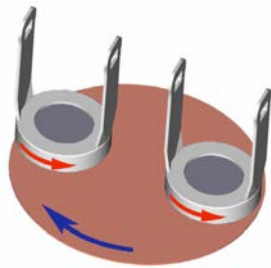
The Vario-Planetary Mill PULVERISETTE 4 is able to simulate conventionally designed ball mills, replicate the types of loads in these mills and, by doing so, reproduce or optimise grinding processes. The flexibility when it comes to selecting grinding parameters makes it possible to achieve results unrivalled by other ball mills.

It is the ideal mill for mechanical activation and alloying. The main applications are for material research and other applications that require a high performance, innovative laboratory planetary mill.



With a particle feed size of  $< 10 \text{ mm}$ , it is possible to achieve a final fineness of up to  $0.1 \text{ }\mu\text{m}$ . The useful capacity is between  $2 \times 5 \text{ ml}$  for  $12 \text{ ml}$  grinding bowls and  $2 \times 225 \text{ ml}$  when using  $500 \text{ ml}$  grinding bowls.

### 2.2.1 Operating principle

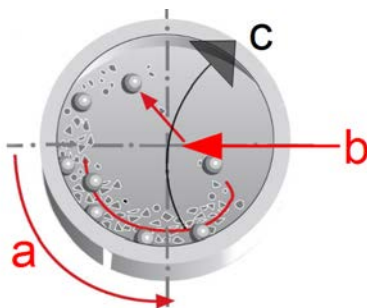


The grinding bowls for planetary ball mills can be rotated and placed off-centre on a rotating support disc. The rotational speed of the support disc can be selected. The grinding bowl rotates at a fixed gear ratio. The rotation of the grinding bowls and the support disc in conjunction causes the grinding stock and grinding balls to describe movements and trajectories inside the grinding bowl, movements whose shape and impact is determined by the gear ratio. Comminution occurs due to the combination of friction and high-energy impacts. Planetary ball mills with a fixed gear ratio have been optimised for single processes.

The rotation speeds of the grinding bowls and support disc can be set entirely independent of one another with the Vario-Planetary Mill PULVERISETTE 4. The movements and trajectories of the grinding balls can be adjusted as desired by varying the gear ratio: the balls can be caused to impact the walls of the bowl vertically (high impact energy), approach the wall tangentially (high friction), or simply roll on the inner wall of the bowl (centrifugal mill).

All intermediate stages and combinations of frictional and impact pressure can be set. This makes it possible for the first time to perform both mechanical activation as well as mechanical alloying with a single mill by changing the gear ratio.

Furthermore, for the first time a planetary ball mill can be ideally adjusted to the grinding stock being comminuted and the size of the grinding bowls and balls.



### 2.3 Obligations of the operator

Before using the PULVERISETTE 4, this manual is to be carefully read and understood. The use of the PULVERISETTE 4 requires technical knowledge; only commercial use is permitted.

The operating personnel must be familiar with the content of the operating manual. For this reason, it is very important that these persons actually receive the present operating manual. Ensure that the operating manual is always near the device.

The PULVERISETTE 4 may exclusively be used within the scope of applications set down in this manual and within the framework of guidelines put forth in this manual. In case of non-compliance or improper use, the customer assumes full liability for the functional capability of the PULVERISETTE 4 and for any damage or injury arising from failure to fulfil this obligation.

## Safety information and use

By using the PULVERISETTE 4 the customer agrees with this and recognizes that defects, malfunctions or errors cannot be completely excluded. To prevent risk of damage to persons or property or of other direct or indirect damage, resulting from this or other causes, the customer must implement sufficient and comprehensive safety measures for working with the PULVERISETTE 4.

Neither compliance with this manual nor the conditions and methods used during installation, operation, use and maintenance of the PULVERISETTE 4 can be monitored by Fritsch GmbH. Improper execution of the installation can result in property damage and thus endanger persons. Therefore, we assume absolutely no responsibility or liability for loss, damage or costs that result from errors at installation, improper operation or improper use or improper maintenance or are in any way connected to these.

The applicable accident prevention guidelines must be complied with.

Generally applicable legal and other obligatory regulations regarding environmental protection must be observed.

## 2.4 Information on hazards and symbols used in this manual

### Safety information

Safety information in this manual is designated by symbols. Safety information is introduced by keywords that express the extent of the hazard.



#### **DANGER!**

This symbol and keyword combination points out a directly hazardous situation that can result in death or serious injury if not avoided.



#### **WARNING!**

This symbol and keyword combination points out a possibly hazardous situation that can result in death or serious injury if not avoided.



#### **CAUTION!**

This symbol and keyword combination points out a possibly hazardous situation that can result in slight or minor injury if not avoided.

## Safety information and use



### NOTICE!

This symbol and keyword combination points out a possibly hazardous situation that can result in property damage if not avoided.

### Special safety information

To call attention to specific hazards, the following symbols are used in the safety information:



### DANGER!

This symbol and keyword combination points out a directly hazardous situation due to electrical current. Ignoring information with this designation will result in serious or fatal injury.



### DANGER!

This symbol and keyword combination designates contents and instructions for proper use of the machine in explosive areas or with explosive substances. Ignoring information with this designation will result in serious or fatal injury.



### DANGER!

This symbol and keyword combination designates contents and instructions for proper use of the machine with combustible substances. Ignoring information with this designation will result in serious or fatal injury.



### WARNING!

This symbol and keyword combination points out a directly hazardous situation due to movable parts. Ignoring information with this designation can result in hand injuries.



### WARNING!

This symbol and keyword combination points out a directly hazardous situation due to hot surfaces. Ignoring information with this designation can result in serious burn injuries due to skin contact with hot surfaces.

## Safety information and use

### Safety information in the procedure instructions

Safety information can refer to specific, individual procedure instructions. Such safety information is embedded in the procedure instructions so that the text can be read without interruption as the procedure is being carried out. The keywords described above are used.

Example:

1. ➤ Loosen screw.

2. ➤



**CAUTION!**  
Risk of entrapment at the lid.

Close the lid carefully.

3. ➤ Tighten screw.

### Tips and recommendations



*This symbol emphasises useful tips and recommendations as well as information for efficient operation without malfunction.*

### Further designations

To emphasise procedure instructions, results, lists, references and other elements, the following designations are used in this manual:

Designation	Explanation
➤ 1., 2., 3. ...	Step-by-step procedure instructions
⇒	Results of steps in the procedure
↗	References to sections in this manual and relevant documentation
■	Lists without a specific order
[Button]	Operating elements (e.g. push button, switch), display elements (e.g. signal lamps)
'Display'	Screen elements (e.g. buttons, function key assignment)

## 2.5 Device safety information

Please observe!

- Only use original accessories and original spare parts. Failure to observe this instruction can compromise the safety of the machine.
- Accident-proof conduct is to be strictly followed during all work.
- Comply with all currently applicable national and international accident prevention guidelines.



### **CAUTION!**

#### **Wear hearing protection!**

If a noise level of 85 dB(A) is reached or exceeded, ear protection should be worn to prevent hearing damage.



### **WARNING!**

The maximum accepted concentration (MAC) levels of the relevant safety guidelines must be observed; if necessary, ventilation must be provided or the machine must be operated under an extractor hood.



### **DANGER!**

#### **Explosion hazard!**

- When grinding oxidizable substances, e.g. metals or coal, there is a risk of spontaneous combustion (dust explosion) if the share of fine particles exceeds a certain percentage. When grinding these kinds of substances, special safety measures must be taken and the work must be supervised from a specialist.
- The PULVERISETTE 4 is not explosion protected and is not designed to grind explosive materials.

- Do not remove the information signs.



### **NOTICE!**

Immediately replace damaged or illegible information signs.

- Unauthorised alteration of the PULVERISETTE 4 will void Fritsch's declaration of conformity to European directives and void the guarantee.
- Only use the PULVERISETTE 4 when it is in proper working order, as intended and in a safety- and hazard-conscious manner adhering to the operating manual. In particular, immediately rectify any malfunctions that could pose a safety hazard.
- If, after reading the operating manual, there are still questions or problems, please do not hesitate to contact our specialised personnel.

## Safety information and use

### 2.6 Protective equipment



*Protective equipment must be used as intended and may not be disabled or removed.*

*All protective equipment must be checked regularly for integrity and proper functioning.*

Start-up is only possible with the hood closed.

The hood is locked:

- without mains connection
- during operation



*The hood can only be opened when the mill's drive is at standstill.*

#### 2.6.1 Opening the hood without mains connection



1. ➤ Unscrew the grating on the left side of the device at the top.



2. ➤ Insert the provided triangular key into the manual release of the safety interlock (through the bore hole) and turn it to the right.
3. ➤ The hood releases after the twist lock on the front side of the hood is opened.
4. ➤ The mill cannot be turned on now. To turn it on, the safety lock has to be activated by turning the triangular key to the left and the hood and hood lock must be locked.

### 2.7 Hazardous points

- Crushing hazard when closing the hood
- Crushing hazard at the grinding bowl clamping device

## **2.8 Electrical safety**

### **2.8.1 General information**

- The main switch separates the whole device from the power supply on all poles.
- Switch off the main switch if the device will be idle for a longer period of time (e.g. overnight).

### **2.8.2 Protection against restart**

In case of power failure during operation or after switching off with the main switch, the hood is locked. The hood lock is opened when power returns. For safety reasons, however, the mill does not restart.

### **2.8.3 Overload protection**

In the event of an overload, the device reduces the speed in a controlled manner. If the main disc is overloaded error code 7 or 8 flashes in the display. The device switches off if the drive motor becomes too hot. The device switches off if the drive is blocked. (See ↗ *'Repairs'* on page 47)

## Technical data

### 3 Technical data

#### 3.1 Dimensions

130 x 70 x 70 cm (height x width x depth)

#### 3.2 Weight

320 kg

#### 3.3 Operating noise

Emissions value of workplace according to DIN EN ISO 3746:2005 is 70 dB (A). The value fluctuates strongly, depending on the speed, the grinding stock and the type of grinding bowl and grinding balls.

#### 3.4 Voltage

400 V, 3 ~

230 V, 3 ~ with special transformer (order no. 04.1800.00)

(See also ⚡ 'Installation' on page 18)

Transient overvoltages in accordance with overvoltage category II are permitted.

#### 3.5 Current consumption

With 400 V mains voltage, the current consumption is 15 A.

#### 3.6 Power consumption

Depending on the mains voltage, the maximum power consumption is as follows:

■ 10000 VA

#### 3.7 Electrical fuses

Fuses depend on the mains voltage. Please refer to the type plate.

Various fuses for the motor drives, fans and control transformers are located in the drawer on the lower right side.



**CAUTION!**

Only trained personnel are authorized to open and check the electrical equipment.

### **3.8 Material**

- Maximum feeding size approx. 10 mm

### **3.9 Final fineness**

- Dry grinding up to  $d_{50} < 20 \mu\text{m}$  (depending on the material)
- Wet grinding up to  $d_{50} < 1 \mu\text{m}$  (depending on the material)

## 4 Installation

### 4.1 Transport

The device is delivered on a transport pallet with a wooden cover. We recommend using a forklift or pallet truck for transporting the packed device.



#### **DANGER!**

Do not step under the transport pallet during transport.



#### **WARNING!**

Improper lifting can lead to personal injury or property damage. The machine is only to be lifted with suitable equipment and by qualified personnel.

The guarantee excludes all claims for damage due to improper transport.

### 4.2 Unpacking

- Pull out the nails that fasten the hood to the transport pallet. The hood is the wooden case that has been placed over the transport pallet.
- Lift the hood off the transport pallet.
- Compare the contents of the delivery with your order.



*Grinding bowls made of hardened steel may have recesses on the surface caused during production. They do not have an impact on grinding or the grinding results and usually disappear after the first grinding operation.*

*These recesses on the surface, if present, are within the range of the permissible production tolerances. Complaints relating to such grinding bowls therefore cannot be accepted.*

## 4.3 Setting up



### DANGER!

Do not step under the transport pallet during transport.



### CAUTION!

Gewicht der Vario - Planetenmühle beträgt ca. 320 kg!



### NOTICE!

Never operate the mill while it is standing on the transport pallet!



### NOTICE!

Keep any obstructions away from the air outlet on the side ventilation grate. Risk of overheating!




### NOTICE!

Place the mill on a flat, stable surface. Block the two front wheels by pressing on the pedals.

- Lift the mill of the transport pallet using a crane.

Procedure:

1. ➤ Open the hood (see  'Protective equipment' on page 14)
2. ➤ Attach the crane hooks to the lifting lug.



## Installation



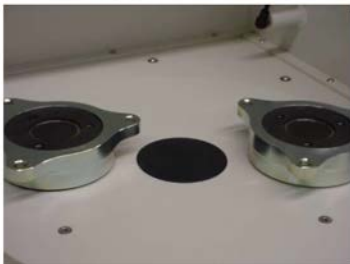
**3.** Carefully lift the machine and place it into position.



**4.** After positioning it, remove the lifting lug.



**5.** Attach the cover!



#### 4.4 Ambient conditions

**WARNING!****Mains voltage!**

- The device may only be operated indoors.
- The surrounding air may not carry any electrically conductive dust.
- Maximum relative humidity 80% for temperatures up to 31°C, linearly decreasing down to 50% relative humidity at 40°C.

- The room temperature has to stay between 5 - 40°C.
- Altitudes up to 2000 m
- Degree of pollution 2 according to IEC 664.

#### 4.5 Electrical connection

**DANGER!****Provide short-circuit protection!**

Risk of damage due to short-circuits.

- Make sure that the socket is connected to a mains line protected with a residual current circuit breaker.

**DANGER!****Mains voltage!**

Changes to the connection line may only be made by a qualified person.

**CAUTION!**

Ignoring the values on the type plate may result in damage to the electrical and mechanical components.

Before establishing the connection, compare the voltage and current values stated on the type plate with the values of the mains system to be used.

## Installation



### NOTICE!

Fritsch mills are speed controlled. The devices are equipped for this with frequency converters. In order to comply with the EMC directive, many measures must be taken to prevent operational transient emissions.

The possible leakage currents resulting from filtering measures can trigger a conventional residual current circuit breaker in the mains line. **This is no defect!**

To prevent this, special residual current circuit breakers, which are adapted for operation with frequency converters, are commercially available.

Operation without a residual current switch is possible, but must be done in accordance with the relevant regulations.

## 4.6 Connecting the computer

An RS232 interface is located on the front panel of the P-4. Connect this interface to the RS232 interface on your computer.

## 4.7 Adjusting the mains voltage

The PULVERISETTE 4 is supplied for connection to a 400 V 3-phase electrical supply only. To adapt it to a different supply network, it must be connected through a 3-phase converter (04.1800.00).

Technical data:

- Primary 200 V 3-phase or 230 V 3-phase
- Secondary 400 V 3-phase
- Power consumption 10000 VA
- Connection cable 5 m without plug

## 4.8 Detection of the direction of rotation

It is essential that the phase sequence of the electrical supply is connected in the correct order.

If the phase sequence is correct, the mill will perform properly.

If it is wrong, it will still be possible to operate the mill via the keyboard, but the mains voltage will not be switched internally. Error code 7 or 8 will appear in the display (see ↗ 'Repairs' on page 47).

## 5 Initial start-up

Perform initial start-up only after all work as described in ↗ 'Installation' on page 18 has been carried out.

### 5.1 Switching on



- Connect the device to the grid
- Switch the device on at the main switch (I ON)

### 5.2 Function check

- Open the hood.
- Take out any grinding bowl clamping devices and wood - the grinding bowl holder must be completely empty - and close the hood.
- Hold down the Program button until "1" appears on the LED display. (In the delivery condition only memory location 1 has been allocated a low motor speed).
- Press START button.
- The hood is locked and the mill runs at the programmed speed.

### 5.3 Switching off

- Press the STOP button.
- After a short time, once the mill is at standstill, the hood is unlocked and can be opened.

## 6 Using the device



### **DANGER!**

Before starting the machine, make sure that the grinding bowl has been tensioned correctly and that there are no loose parts inside the device. There is a risk of loose grinding bowls or parts being projected. Failure to observe this will render void the guarantee, and releases us from liability for any resulting damage to the device or personal injury.



### **NOTICE!**

During grinding, the temperatures in the grinding bowl may get very high.

In encased grinding bowls, the inserts are glued into the casing with a two-component construction adhesive.

The adhesive is resistant to temperatures up to approx. 140 °C. Above 140 °C, the adhesive will liquefy and accumulate below the insert in the casing. When the adhesive cools down, it solidifies and pushes the casing up. That can cause irreparable damage to the insert. The grinding bowl will definitely be rendered unusable.

Above temperatures of 200 °C, the adhesive will be destroyed. The same applies for encased grinding bowl lids.



*V-belt, seals, and motor require some time at the beginning before they can reach the optimal output and/or rotation. This means that initially a well-filled and heavy grinding set may be able to operate with less rotations than after an introductory phase of approx. 1 - 2 hours running time.*

### 6.1 Choice of grinding bowls and grinding balls



### **CAUTION!**

If the grinding elements used are not genuine accessories, we assume no guarantee and exclude all liability for damage to the device or for personal injury.



## Using the device



### CAUTION!

The grinding element is subject to normal wear when used. Before every grinding operation, check the wall thickness of the grinding bowls. In the event of severe wear, replace the grinding bowl. If this is not done, the prevailing high centrifugal forces during grinding may cause the grinding balls to penetrate the bowl's wall and damage the mill. Failure to observe this will render void the guarantee and release us from liability for any resulting damage to the device or personal injury.

The hardness and density (specific weight) of the grinding bowl and grinding balls used must be greater than that of the material used to prevent excessive wear by abrasion.

Material (bowl and balls)	Main components of the material	Density in g/cm <sup>3</sup> High density means high impact energy!	Abrasion resistance	Use for grinding stock
Agate	(99.9% SiO <sub>2</sub> )	2.65	Good	Soft to medium-hard samples
Silicon nitride	(90% Si <sub>3</sub> N <sub>4</sub> )	3.25	Extremely good	Abrasive samples, metal-free grinding
Sintered corundum	(99.7% Al <sub>2</sub> O <sub>3</sub> )	3.9	Fairly good	Medium-hard, fibrous samples
Zirconium oxide	(96,2% ZrO <sub>2</sub> )	5.7	Very good	Fibrous, abrasive samples
Stainless steel	Bowl: (17-19% Cr + 8-10% Ni)  Balls: (12.5-14.5% Cr + 1% Ni)	7.8	Fairly good	Medium-hard, brittle samples
Hardened steel	Bowl: (11-12% Cr) Balls: (1.0-1.65% Cr)	7.9	Good	Hard, brittle samples
Tungsten carbide	(93% WC+6% Co)	14.9	Very good	Hard, abrasive sam- ples

The grinding bowls and grinding balls made of zirconium oxide are resistant to acids - apart from hydrofluoric acid.

## Using the device

Normally choose a grinding bowl and grinding balls that are made of the same material.

Exception: Tungsten carbide balls (<20 mm) may be temporarily (a few minutes) combined with grinding bowls made of hardened steel.

### 6.1.1 Size of the grinding balls

Type of feed material	Suitable ball diameter
Hard samples with a maximum feed size of 10 mm	30 mm or 40 mm
Average feed size of < 5 mm	20 mm
Fine material < 0.5 mm	10 mm or 5 mm
Homogenisation of dry or liquid samples	10 mm
Homogenisation of viscous samples	20 mm

**These are reference values: The size of bowls and grinding balls may need to be determined through experimentation.**



#### NOTICE!

It is not advisable to mix balls of different diameters. (If balls with different diameters are used, increased wear to the balls is to be expected.)



#### NOTICE!

Balls with a diameter of 40 mm are rarely used for grinding, because this ball size can cause damage to the grinding bowl fast if the grinding duration is too long. Only use grinding balls of this diameter for brief grinding durations.

### 6.1.2 Number of balls per grinding bowl (independent of the material quantity)

A higher number of balls will reduce the grinding time and the grinding result will have a smaller particle size distribution.

Ball diameter (mm)	Grinding bowl volume (ml)	80	250	500
5	Number of balls (pcs)	250 - 300	1200 - 1300	2000 - 2500
10	Number of balls (pcs)	25 - 30	50 - 150	100 - 250
15	Number of balls (pcs)	10	45 - 50	70 - 100
20	Number of balls (pcs)	5	15 - 20	25 - 35
30	Number of balls (pcs)	-	5 - 6	10
40	Number of balls (pcs)	-	-	4

These are reference figures: The number of balls may need to be determined through experimentation.



#### CAUTION!

When grinding with a ball size of Ø 30 mm or Ø 40 mm, do not let the device run unsupervised. The vibrations may lead to shifting.

## Using the device

### 6.1.3 Calculated weight of a ball

Ball diameter in mm		5	10	15	20	30	40
Material	Density in g/cm <sup>3</sup>	Calculated weight of a ball in g					
Agate	2,65	0,17	1,39	4,68	11,1	37,46	88,8
Silicon nitride	3,25	0,21	1,7	5,74	13,61	45,94	108,91
Sintered corundum	3,9	0,25	2,04	6,89	16,33	55,13	130,69
Zirconium oxide	5,7	0,37	2,99	10,07	23,88	80,58	191,01
Stainless steel	7,8	0,51	4,08	13,78	32,67	110,27	261,38
Hardened steel	7,9	0,52	4,13	13,96	33,09	111,68	264,73
Tungsten carbide	14,9	0,97	7,8	26,33	62,41	210,64	499,3

To determine the weight of the required balls, the "calculated weight of a ball" is multiplied by the "number" of balls required.

Example: A 250 ml agate bowl is to be filled with 1221 agate balls with a diameter of 5 mm.

Calculation:  $0.17\text{g} * 1221 \text{ St} \approx 208 \text{ g}$

208 g of grinding balls can be weighed and inserted in the grinding bowl, thus avoiding the time required for counting the balls.

## 6.2 Filling quantities of grinding bowls



#### CAUTION!

For wet grinding with large balls with a diameter of >10 mm, at least half the maximum sample quantity must be inserted. If the suspension is highly fluid, the balls will not have any resistance and the balls and the grinding bowl could be damaged. The result is the same as if it had been filled with no grinding stock. The same applies to dry grinding with less than the minimum sample quantity.



#### NOTICE!

Never operate the mill without grinding stock! This can lead to grinding balls and grinding bowls getting damaged.

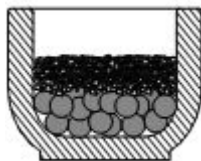


## NOTICE!

If the minimum filling quantity is fallen short of, increased wear due to abrasion is to be expected. This can cause irreparable damage to the mill components.

Grinding bowl	Grinding bowl	max. sample volumes
500 ml	80 ml	225 ml
250 ml	30 ml	125 ml
80 ml	1 ml	30 ml

## 6.3 Filling the grinding bowl



**Do not fail to comply with the following sequence:**

1. ➔ Place the grinding balls in the empty bowl.
2. ➔ Fill grinding stock onto the balls.
3. ➔ Place the sealing ring on the rim of the grinding bowl.



## NOTICE!

Make sure the sealing surfaces are clean!

4. ➔ Place the lid on the grinding bowl.

## 6.4 Factors with an impact on grinding

### 6.4.1 Running time (grinding duration)

A longer grinding time will increase the percentage of fine material. To reduce the grinding time, you can use a grinding bowl and grinding balls with a higher density, and thus a higher impact energy.

### 6.4.2 Speed

Higher speeds shorten the grinding time and increase the share of fine particles.

## Using the device

### 6.4.3 Reverse mode

- Useful for mechanical alloying
- Improvement of the homogeneity of the sample


### 6.4.4 Number and size of the balls

Pre-grind coarse, hard material with large balls:

reduced percentage of fine material!

Many small balls increase the percentage of fine material during extended running time.

### 6.4.5 Weight of the balls (type of material)

A higher mass (specific weight) of the grinding balls accelerates grinding. (see table in  'Choice of grinding bowls and grinding balls' on page 24).

### 6.4.6 Dry grinding

Below a particle size of approx. 20 µm, the surface forces prevail. The grinding stock begins to stick.

Additional dry comminution can be achieved by adding surface-active substances to the material to be ground.

Examples (maximum amount to be added in mass%)

- Stearic acid 2-3%
- Aerosil (fine-particle silicic acid) 0.5 - 2%
- Quartz sand ~ 2%
- Glass powder ~ 2%
- Glycol (Ethylene glycol) ~ 0.1 - 0.5 % ( $\triangleq$  5 - 25 droplets)
- Triethanolamine ~ 0.1 - 0.5 %

#### 6.4.7 Wet grinding (grinding in a suspension)

**DANGER!****Explosion hazard! Ignition hazard!**

The device is not explosion-protected. If flammable liquids are used, make sure that the heat developing in the grinding bowl does not reach the solvent's boiling point. Program appropriate cooling phases. If the vapour pressure is too high, vapours may escape and ignite. If it can be avoided, we recommend using non-flammable liquids or liquids with a high boiling point. The boiling point should be above 80 °C and above 100 °C for a long grinding duration.

During the transition to grinding in suspension, you can add a liquid auxiliary agent with high boiling point and low vapour pressure.

#### 6.5 Clamping the grinding bowls

Carry out the following checks for every grinding before clamping the grinding bowls:

- Check the rubber disc in the grinding bowl holder for damage:  
Replace the rubber disc if it has been pressed flat. (The rough side must face upwards!)
- The Teflon flat seal (for the seal between the lid and the bowl) should not be damaged or soiled.  
Replace heavily deformed Teflon flat seals.
- The lid and bowl surfaces that contact the Teflon flat seal must be clean.

## Using the device

### 6.5.1 Clamping the 500 ml, 250 ml and 80 ml grinding bowls



#### CAUTION!

When using the 80 ml grinding bowl:

- Use the reduction adapter (Art. No. 90.1120.09) or
- clamp two 80 ml grinding bowls on top of one another.

1. ➤ Place the grinding bowl into the holder.
2. ➤ Then place the clamping plate (a) onto the bowl lid.

3. ➤ Insert the provided hexagon screws with blue shaft (b) into the corresponding bore holes.



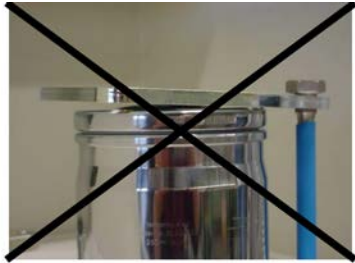
#### NOTICE!

Hexagon screw with:

- blue shaft is for standard bowls with standard lids and standard bowls with gassing lids
- red shaft for GTM systems, additional lock systems and combinations of gassing lid with additional lock system.



## Using the device



4. ➔ Turn the three hexagon screws evenly by hand until all screw heads lie on the clamping plate.



5. ➔ Then tighten all three hexagon screws evenly using the face pin spanner and the ring spanner.



### NOTICE!

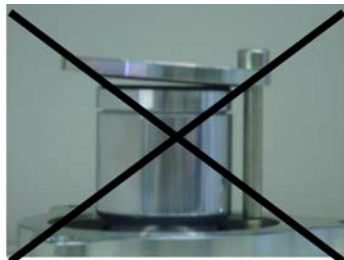
- Do not turn the heads off the screws!
- If the clamping plate is not sufficiently tightened, the sample material can be forced out of the grinding bowl, or the grinding bowl can slip out of the clamping device and damage the machine. Fritsch GmbH can accept no responsibility for improper handling.
- After several minutes of grinding and in the cooling-down phases, check that the clamping device is firmly seated.

### 6.5.2 Clamping the 45 ml and 12 ml grinding bowls



1. ➔ Place the grinding bowl into the holder.
2. ➔ Then place the clamping plate (c) onto the bowl lid.

## Using the device



3. ➔ Insert the provided hexagon socket screws (d) into the corresponding bore holes.
4. ➔ Turn the three hexagon socket screws evenly by hand until all screw heads lie on the clamping plate.

5. ➔ Then tighten the three hexagon socket screws evenly using the hex key.



### NOTICE!

- Do not turn the heads off the screws!
- If the clamping plate is not sufficiently tightened, the sample material can be forced out of the grinding bowl, or the grinding bowl can slip out of the clamping device and damage the machine. Fritsch GmbH can accept no responsibility for improper handling.
- After several minutes of grinding and in the cooling-down phases, check that the clamping device is firmly seated.

## 6.6 Mass balance

### Load the mill symmetrically

Always clamp an equally heavy grinding bowl with lid and sealing ring in the opposite grinding bowl holder to balance the weight!



### NOTICE!

Extra weights, like "GTM" and "additional clamping system", have to be balanced as well.

## 6.7 Grinding duration



### WARNING!

#### Burn hazard!

Grinding bowls can get very hot after long grinding durations. Wear protective gloves for removal after grinding or during the grinding breaks.

Depending on the application, the grinding duration should be adapted to the development of heat in the bowls. The temperature inside the bowls is 20 - 30 °C warmer than the outer casing temperature.



### CAUTION!

The maximum temperature of the grinding bowl outer casing is 100 - 110 °C (agate, max. 70 - 80 °C).

The grinding duration is therefore based on the maximum bowl temperature. The grinding duration at which the temperature is not exceeded depends on the material, ball, and speed. For this reason, the user should determine it through experimentation.

### Reference value

When grinding at high speeds and with large bowls, a grinding duration of one hour (depending on the temperature) should not be exceeded. Then allow the unit to cool down for half an hour to one hour.



### NOTICE!

- Observe the warming up of the grinding stock.
- A longer running time may require pause times for cooling down.
- Check that the tensioning device is firmly connected when switching on again after a cooling-down phase.



### NOTICE!

If bowls are removed during a grinding pause, check that they fit correctly before the device is switched back on.



*The extent to which the heating up of grinding stock needs to be observed depends on the sample used in each individual case. Note → A longer running time may also require a longer pause time for cooling down.*

## Using the device

To reduce the grinding time, you can use a grinding bowl and grinding balls with a higher density, and thus a higher impact energy.

The mill can also run for several hours during low-speed operations for mixing and homogenisation.

Operation with an external time switch is not possible.

### 6.8 Settings on the control panel

- Switch on the main switch (8) on the right-hand side of the machine.
- The LED display lights up.

#### 6.8.1 Select program

By pressing the "program" key, program storage locations 1 - 9 are selected. The rotational speeds of the main disc and of the planet gears, the milling duration, the pause times, the number of repeats of milling and pause times and reverse mode can be stored in these storage locations.

#### 6.8.2 Start the mill

After the conditions specified in ↗ 'Using the device' on page 24 have all been observed, close the hood. After pressing the START key, the mill starts. The machine runs at the rotational speed, etc. as stored in the displayed program storage location.

#### 6.8.3 Switching off

On pressing the STOP key, the mill brakes the main disk and the planet gears to a complete standstill. This procedure can take several seconds. See ↗ 'Conducting a grinding operation' on page 37.

#### 6.8.4 Meaning of the LED display

##### Display: 0

After a loss of electrical power during milling, the residual running time is stored in location 0 (maximum inaccuracy is 1 hour). After switching on again, the remaining time is displayed in storage location "0".



##### Display: 1-9

These are the program storage locations 1 - 9

##### Flashing display 5-9

See  'Repairs' on page 47

## 6.9 Conducting a grinding operation


- After the conditions specified in  'Using the device' on page 24 have all been observed, close the hood.
- Press the START button on the control panel.
- The hood is locked and the mill starts up.
- The mill turns at the set speed (nominal speed). If the load is too great, for example due to heavy grinding bowls, the speed is reduced (actual speed) so that the machine is not overloaded.  
→ If the mill does not start, see  'Repairs' on page 47



*While in operation, the hood remains locked, even during pause times, and the fan cools the interior.*

### 6.9.1 Overload

If the mill is overloaded, the rotational speed is reduced.

The mill switches off if the overload continues for too long; see  'Repairs' on page 47.

### 6.9.2 Interrupt a grinding process

- After selecting the program and pressing the START key on the mill, an internal timer begins to run. It is possible in this way to check the milling progress by pressing the STOP key on the machine, checking the grinding state and then pressing the START key again on the machine to continue the grinding with no loss of time. Also if the mill is stopped during the pause time, the milling will be continued after pressing the START key.
- If the START button is pressed in the PC program, all total times will be transferred, whereby no residual running times or pause times will be taken into account. The grinding starts again from the beginning.
- The residual times are saved after every hour as a precaution. If milling is performed over a longer time period and the electrical power is cut off, the residual time can be re-run (maximum inaccuracy is < 1 hour). Functional principle: When the mill is reconnected to electrical power, the software recognises the residual time stored and indicates this through a 0 in the display. If the START key on the machine is now pressed, the grinding is continued.  
The residual time can be read off in the program.

## Using the device



*As soon as the START button in the program has been processed, the residual time is lost.*

### 6.9.3 Switching off

- Press STOP on the control panel.
- When the drive comes to a standstill, the hood is unlocked and can be opened.
- Switch off the main switch (8) on the right-hand side of the machine.

### 6.10 Cooling the grinding bowl

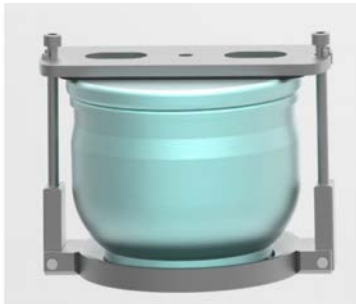
- When the hood is open or
- In the programmed pause times with closed (locked) hood and the fan running.

## 7 Accessories

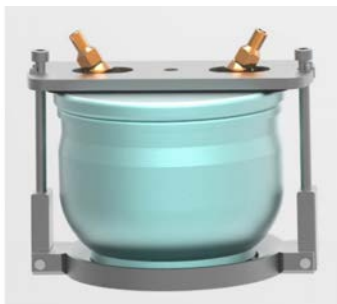
### 7.1 Additional clamping system for grinding harmful substances or in a gas atmosphere.

The additional clamping system is used to transport a grinding bowl filled with inert gas or harmful substances from a glove box to the planetary mill and back again. This ensures that no harmful substances can be inhaled.

**There are two ways of gassing the grinding bowls:**

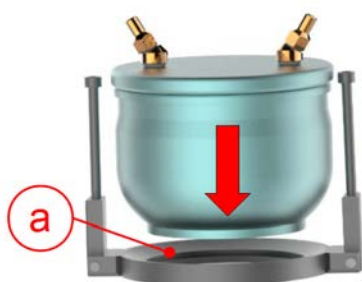


1. ➤ Grinding bowls with standard lids have to be filled in a glove box with an inert gas atmosphere and closed using the additional clamping system. Using this procedure you can even grind hazardous substances!



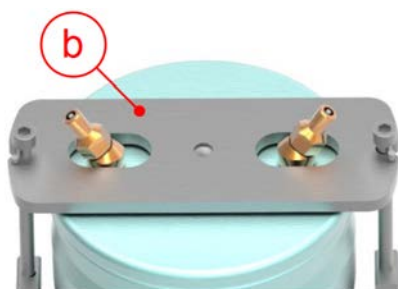
2. ➤ Grinding bowls with gassing lids can also be closed and gassed outside the device using the additional clamping system.

#### 7.1.1 Locking the additional clamping system into place

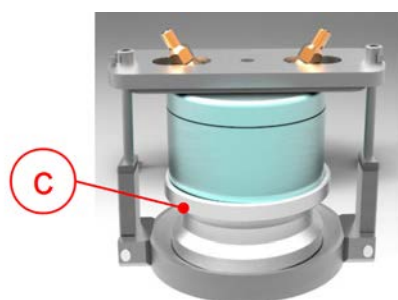


1. ➤ Place the grinding bowl in the additional clamping system.

## Accessories



2. ➤ Position the pressure plate (b) with rubber disc on the bowl as shown in the picture.



3. ➤ When using grinding bowls with a volume of 80 ml, the adapter (90.1120.09) (c) must be used in addition.



### NOTICE!

Under no circumstances may 2 x 80 ml bowls be clamped on top of one another. This can lead to damage to the bowl and its component seals.



4. ➤ Then secure the pressure plate on both sides with the hexagon socket screws shown in the picture using a hex key.



5. ➤ Place the additional clamping system with secured bowl in the grinding bowl holder.





6. This is done as described in ↗ 'Clamping the 500 ml, 250 ml and 80 ml grinding bowls' on page 32. However, the hexagon screws with the **red** shaft must be used.



### NOTICE!

After tensioning the pressure plate, the hexagon socket screws of the additional clamping system must be checked for tightness and tightened again if necessary.

### 7.1.2 Grinding in inert gas with gassing lid



### NOTICE!

Observe imbalance offsetting! (See ↗ 'Mass balance' on page 34).



### NOTICE!

Before every grinding operation, check the valves of the gassing lid ensuring that they are clean and properly secured. See chapter ↗ 'Cleaning the valves' on page 43.



*We carry out a worker water bath test on all gassing lids. The part to be tested is sealed, a pressure of 5.5 bar is applied and it is immersed in a water bath. If there is a leak, bubbles will develop. The air bubbles that develop within a specific interval are evaluated by the worker/tester.*

*Only gassing lids with a leak rate of  $< 10^{-4}$  [mbar l/s] are approved.*

When grinding in inert gas, the same conditions apply regarding clamping and composition of grinding set and balls, as apply for standard grinding.

Two valves are screwed onto the gassing lid through which you can feed in inert gas (e.g. nitrogen) before switching on the mill. A Viton flat seal is used instead of a Teflon one.

## Accessories

### 7.1.2.1 Preparation for gassing



- a Gassing hose
- b Hose clamp
- c Coupling
- d Valves
- e Ventilation attachment

- Fill the grinding bowl with grinding balls and grinding stock. (See [‘Filling the grinding bowl’ on page 29](#))
- Attach the Viton seal and lid.
- Insert the grinding bowl into the grinding bowl holder (8).
- Clamp the grinding bowl in the device (See [‘Clamping the 500 ml, 250 ml and 80 ml grinding bowls’ on page 32](#))

**Using the additional clamping system, the following steps can also be completed in the glove box and subsequently clamped in the Vario-Planetary Mill:**

- Connect the gassing hose (a) to the inert gas supply using the provided hose clamp (b).
- Screw the ventilation attachment (e) onto one of the two valves (d).
- Place the coupling (c) of the gassing hose on the free valve. When doing so, press the lever of the coupling and push the coupling along the neck of the valve until it goes no further. Release the lever.



*Using the additional clamping system, the closed grinding bowl can also be tensioned and gassed outside of the device. (See [‘Locking the additional clamping system into place’ on page 39](#))*

### 7.1.2.2 Gassing

- Slowly open the inert gas supply.
- Press a thin object (e.g. hex key) onto the top of the ventilation attachment (e) so that the air can escape from the grinding bowl.
- The inert gas now purges the air from the grinding bowl.
- The duration of purging has to be determined through experimentation.  
It depends on grinding bowl size, filling, and gas supply, among other factors.
- To end purging, close the inert gas supply and release the ventilation attachment.
- Screw off the ventilation attachment.
- Remove the gassing hose. To do so, press the lever.



### CAUTION!

Only switch on the device when both coupling and ventilation attachment have been removed.

Overpressure may occur during grinding!

### 7.1.2.3 Ventilate after grinding



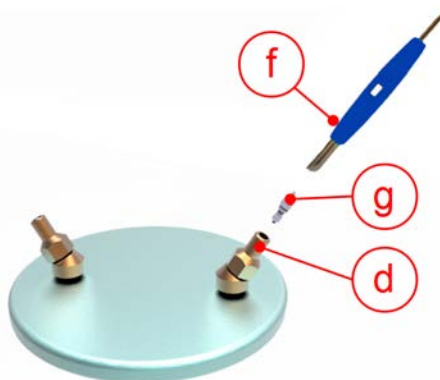
### CAUTION!

Always let the bowl cool down before ventilation. Hot gases and sample material may escape from the bowl during pressure equalisation, leading to serious burns.

→ Use protective gloves when ventilating!

- When the bowl has cooled down, remove the additional clamping system with bowl from the device.
- Screw the ventilation attachment onto the valve. Each valve can be used for aerating or ventilating.
- For pressure equalisation (of the overpressure occurring because of grinding), carefully press on the ventilation attachment with a thin object (e.g. hex key).
- Only now should you release the additional clamping system (5)!

### 7.1.2.4 Cleaning the valves



- f Valve screwdriver
- g Valve insert (84.6360.00)
- d Valves

Both valves (d) should be cleaned after every grinding!

- Insert the thin end of the valve screwdriver (f) from above into the valve (d) and turn anti-clockwise.
- Screw out the valve insert (g).
- Depending on the soiling, clean the valve insert (g) with compressed air, or place it in a small glass container filled with alcohol and clean in an ultrasonic cleaner (LABORETTE 17) and then dry carefully.
- After the two valve inserts have been removed, the two valve holders can be cleaned with compressed air from above the lid.

## Accessories

### 7.1.2.5 Installing valve inserts

- Insert the valve insert (g) into the valve (d) with the spring pointing upwards.
- With the valve screwdriver (f), screw the valve insert clockwise.

The following gassing lids for the grinding sets are available, each with two valves and a soft sealing ring:

Material	Order number
Hardmetal tungsten carbide 250 ml	50.8600.00
Hardened chrome steel 80 ml	50.8700.00
Hardened chrome steel 250 ml	50.8500.00
Hardened chrome steel 500 ml	50.8400.00
Stainless steel 80 ml	50.8800.00
Stainless steel 250 ml	50.8300.00
Stainless steel 500 ml	50.8200.00
Agate 250 ml	50.8100.00
Agate 500 ml	50.8000.00



#### NOTICE!

The soft black sealing rings made of "Viton" can endure temperatures of approx. 200 °C.

The valves (d) can endure temperatures of approx. 180 °C for one hour at most.



#### NOTICE!

The grinding parts made of agate are only designed for temperatures of up to 100 °C. After this point, they need to be slowly and carefully cooled down.

## 7.2 GTM - system

The GTM system is available as an accessory for recording pressure and temperatures in the grinding bowl during grinding.

Instructions are included with the GTM system.

## 8 Cleaning



### DANGER!

#### Mains voltage!

- Before beginning with cleaning work, disconnect the mains plug and protect the device against being unintentionally switched back on!
- Do not allow any liquids to flow into the device.
- Indicate cleaning work with warning signs.
- Put safety equipment back into operation after cleaning work.



*When cleaning the entire device, adhere to the guidelines of the Accident Prevention Regulation (BGV A3) - especially when the device has been set up in a dusty environment or when the grinding stock processed produces dust.*

### 8.1 Grinding elements



### NOTICE!

Cool grinding elements made of agate, sintered corundum, zirconium oxide and silicon nitride slowly and carefully.

Do not heat agate elements in a microwave under any circumstances (heating is too fast).

They must never be exposed to thermal shocks as this could cause irreparable damage to the parts → They will burst apart like in an explosion.

- Clean the grinding bowl and grinding balls each time after using them: Clean them, e.g., under running water using a brush and a commercially available cleaning agent.
- Roughly half fill the grinding bowl with grinding balls and a little sand and water and run for 2 to 3 minutes (correctly tensioned) in the Vario planetary mill.
- Cleaning with an ultrasonic cleaner is permitted.
- For sterilisation in the heat cabinet, only heat the grinding elements up to 100 °C.

### 8.2 Mill

- The Vario planetary mill can be wiped down with a damp cloth after it has been switched off.

## 9 Maintenance



### DANGER!

#### Mains voltage

- Before beginning with maintenance work, unplug the mains plug and protect the device against being unintentionally switched back on again!
- Indicate maintenance work with warning signs.
- Maintenance work may only be performed by specialised personnel.
- Put safety equipment back into operation after maintenance or repair work



We recommend keeping a safety logbook ↗ Chapter 15 'Safety logbook' on page 56, where all work (maintenance, repairs.....) performed on the device is entered.



The most important element of maintenance is regular cleaning:

Functional part	Task or description	Test	Maintenance interval
Safety lock	Hood lock	Hood handle (1) cannot be opened.  If this test is failed, do not continue to work until the fault has been rectified	Before each use!
Rotating bearings	Permanent lubrication	Bearing clearance	Every 2,000 h or annually
Drive motor	Permanent lubrication	Bearing clearance	Every 4,000 h or annually
Fan, ventilation slots	Grinding chamber cooling and electronics	Proper function, clean when soiled	Twice a year
Grinding bowl clamping device	Clamping plate rubber and rubber disk in the grinding bowl holder	Signs of use; replace if pressed flat and no longer elastic	After every 1,000 h
Grinding bowl seal	Seal the grinding bowl	Replace if dirt has penetrated	Every 100 h

## 10 Repairs



### DANGER!

#### Mains voltage!

- Before beginning with repair work, unplug the mains plug and protect the device against being unintentionally switched back on.
- Indicate repair work with warning signs.
- Repair work may only be performed by specialised personnel.
- Put safety equipment back into operation after maintenance work.

Fault description	Cause	Remedy
The ready status indicator doesn't light up	No mains connection	Plug in mains plug
	Main switch (8)	Switch on main switch
START button is pressed but mill does not start up	Check if POWER SUPPLY is lit	see above
	Pause time active	Wait for end of pause or press "STOP"
	Safety lock was opened manually	see ⚡ 'Opening the hood without mains connection' on page 14
Mill reduces speed automatically	if display is blinking: Overload	Reduce load or accept automatically set rotational speed
Mill stops running	Switched off due to thermal overload of the drive	Allow device to cool down and select a lower speed
	Imbalance of machine too high	Improve mass balance, see ⚡ 'Mass balance' on page 34
	Drive was blocked	Rectify malfunction in grinding chamber
	Toothed belt of motor loose or broken	Check toothed belt, replace if necessary
The hood cannot be opened	No mains connection	Plug in mains plug
	Main switch (8)	Switch on main switch
Grinding stock escapes	Clamping device loose	clamp again
	Seal ring is soiled or defective	Clean or replace seal ring
Runs unevenly with strong vibrations	Bowls are imbalanced	Arrange the bowls symmetrically (equal masses in the opposite positions)
Error code 5 blinks in the display	Emergency off switch (5) pressed	Unlatch the emergency off switch
Error code 6	Invalid program data	Rotational speed or grinding duration must not be set to zero.

## Repairs

Fault description	Cause	Remedy
Error code 7	No feedback of rotational speed from planetary drive	See ⚡ 'Electrical safety' on page 15
Error code 8	No feedback of rotational speed from main drive	See ⚡ 'Electrical safety' on page 15
Error code 9	Hood not properly closed	Close the hood and lock it mechanically with the twist grip (1)



## Examples of comminution tasks

### 11 Examples of comminution tasks

Material			
Feeding amount	Material of grinding bowl and balls	Grinding balls, St. x diameter	Result
Feed size	Grinding bowl size	Grinding duration	Final fineness
<b>Ruby (stone)</b>			
140 g	Cr-Ni steel	6 x 30 mm	100%
12 mm	250 ml	3 min	< 250 µm
<b>Titanium dioxide TiO<sub>2</sub> (dry and wet grinding in water)</b>			
40 g	Cr-Ni steel	6 x 30 mm	100%
2 mm	250 ml	30 min	< 40 µm
<b>Titanium dioxide TiO<sub>2</sub> (wet grinding in water)</b>			
40 g / 50 ml water	Cr-Ni steel	6 x 30 mm	100%
2 mm	250 ml	60 min	< 10 µm
<b>Coal (dry and wet grinding in water)</b>			
5 g	Zirconium oxide	5 x 20 mm	100%
0.5 mm	80 ml	120 min	< 15 µm
<b>Aluminium oxide / silicon oxide</b>			
100 g	WC + Co	15 x 20 mm	90%
0.1 mm	250 ml	90 min	< 20 µm
<b>Ferrovanadium</b>			
70 g	WC + Co	5 x 30 mm	70%
3 mm	250 ml	20 min	< 100 µm
<b>Glass</b>			
50 g	Agate	15 x 20 mm	100%
4 mm	250 ml	15 min	< 90 µm
<b>Silicon carbide (dry and wet grinding in water)</b>			
15 g	WC + Co	5 x 20 mm	100%
3 mm	80 ml	30 min	< 150 µm
<b>Silicon carbide (dry and wet grinding in water)</b>			
15 g / 5 ml water	WC + Co	5 x 20 mm	100%
3 mm	80 ml	45 min	< 71 µm

## Examples of comminution tasks

<b>Raw phosphate</b>			
40 g	Cr steel	15 x 20 mm	100%
3 mm	250 ml	2 min	< 250 µm
<b>Manganese dioxide MnO<sub>2</sub> (wet grinding in water)</b>			
50 g / 40 ml water	WC + Co	15 x 20 mm	100%
0.1 mm	250 ml	60 min	< 20 µm
<b>Sludge (dry)</b>			
180 g	Al <sub>2</sub> O <sub>3</sub>	10 x 30 mm	100%
8 mm	500 ml	30 min	< 250 µm
<b>Active carbon (wet grinding in water)</b>			
150 ml	Cr-Ni steel	15 x 20 mm	100%
0.025 mm	250 ml	30 min	< 5 µm
<b>Plaster</b>			
300 g	Cr steel	10 x 30 mm	100%
10 mm	500 ml	20 min	< 200 µm
<b>Protein</b>			
50 g	Sintered corundum 1	6 x 30 mm	90%
20 mm	250 ml	90 min	< 50 µm
<b>Grains (barley)</b>			
100 g	Sintered corundum 1	3 x 40 mm	100%
3 mm	500 ml	20 min	< 150 µm
<b>Dough products</b>			
100 g	Sintered corundum 1	10 x 30 mm	100%
5 mm	500 ml	3 min	< 250 µm
<b>Sugar (wet grinding in alcohol)</b>			
200 g	Agate	10 x 30 mm	100%
1 mm	500 ml	45 min	< 10 µm

## 12 Disposal

It is hereby confirmed that FRITSCH has implemented the directive 2002/95/EC of the European Parliament and Council from 27th January 2003 for the limitation of the use of certain dangerous substances in electrical and electronic devices.

FRITSCH has registered the following categories according to the German electrical and electronic equipment act, section 6, paragraph 1, clause 1 and section 17, paragraphs 1 and 2:

**Mills and devices for the preparation of samples have been registered under category 6 for electrical and electronic tools (except for large stationary industrial tools).**

**Analytical devices have been registered under category 9, monitoring and control instruments.**

It has been accepted that FRITSCH is operating only in the business-to-business area. The German registration number for FRITSCH is WEEE reg. no. DE 60198769

### **FRITSCH WEEE coverage**

Since the registration of FRITSCH is classified for bilateral transactions, no legal recycling or disposal process is described. FRITSCH is not obliged to take back used FRITSCH devices.

FRITSCH declares it is prepared to take back used FRITSCH devices for recycling or disposal free of charge whenever a new device is purchased. The used FRITSCH device must be delivered free of charge to a FRITSCH establishment.

In all other cases FRITSCH takes back used FRITSCH devices for recycling or disposal only against payment.

### 13 Guarantee terms

#### Guarantee period

As manufacturer, FRITSCH GmbH provides – above and beyond any guarantee claims against the seller – a guaranty valid for the duration of two years from the date of issue of the guarantee certificate supplied with the device.

Within this guarantee period, we shall remedy all deficiencies due to material or manufacturing defects free of charge. Rectification may take the form of either repair or replacement of the device, at our sole discretion. The guarantee may be redeemed in all countries in which this FRITSCH device is sold with our authorisation.

#### Conditions for claims against the guarantee

This guarantee is subject to the condition that the device is operated according to the instructions for use / operating manual and its intended use.

Claims against the guarantee must include presentation of the original receipt, stating the date of purchase and name of the dealer, together with the complete device type and serial number.

**For this guarantee to take effect, the answer card entitled "Securing of Guarantee" (enclosed with the device) must be properly filled out and despatched without delay after receipt of the device and be received by us within three weeks or alternatively, online registration must be carried out with the above-mentioned information.**

#### Reasons for loss of the guarantee

##### The guarantee will not be granted in cases where:

- Damage has arisen due to normal wear and tear, especially for wear parts, such as: Crushing jaws, support walls, grinding bowls, grinding balls, sieve plates, brush strips, grinding sets, grinding disks, rotors, sieve rings, pin inserts, conversion kits, sieve inserts, bottom sieves, grinding inserts, cutting tools, sieve cassettes, sieve and measuring cell glasses.
- Repairs, adaptations or modifications were made to the device by unauthorized persons or companies.
- The device was not used in a laboratory environment and/or has been used in continuous operation.
- Damage is present due to external factors (lightning, water, fire or similar) or improper handling.
- Damage is present that only insubstantially affects the value or proper functioning of the device.
- The device type or serial number on the device has been changed, deleted, removed or in any other way rendered illegible
- The above-mentioned documents have been changed in any way or rendered illegible.

## Guarantee terms

### Costs not covered by the guarantee

This guarantee excludes any costs for transport, packaging or travel that accrue in the event the product must be sent to us or in the event that one of our specialist technicians is required to come to your site. Any servicing done by persons not authorised by us and any use of parts that are not original FRITSCH accessories and spare parts will void the guarantee.

### Further information about the guarantee

The guarantee period will neither extend nor will a new period of guarantee begin in the event that a claim is placed against the guarantee.

Please provide a detailed description of the type of error or the complaint. If no error description is enclosed, we shall interpret the shipment as an assignment to remedy all recognisable errors or faults, including those not covered by the guarantee. Errors or faults not covered by the guarantee shall in this case be rectified at cost.

We recommend reading the operating manual before contacting us or your dealer, in order to avoid unnecessary inconvenience.

Ownership of defective parts is transferred to us with the delivery of the replacement part; the defective part shall be returned to us at buyer's expense.



#### NOTICE!

Please note that in the event that the device must be returned, the device must be shipped in the original Fritsch packaging. Fritsch GmbH denies all liability for any damage due to improper packaging (packaging not from Fritsch).

Any enquiries must include a reference to the serial number imprinted on the type plate.

## **14 Exclusion of liability**

Before using the product, be sure to have read and understood this operating manual.

The use of the product requires technical knowledge; only commercial use is permitted.

The product may be used exclusively within the scope of applications set down in this operating manual and within the framework of guidelines put forth in this operating manual and must be subject to regular maintenance. In case of non-compliance, improper use or improper maintenance, the customer assumes full liability for the functional capability of the product and for damage or injury arising from violating these obligations.

The contents of this operating manual are subject in entirety to copyright law. This operating manual and its contents may not be copied, further distributed or stored in any form, in part or in whole, without the prior written consent of Fritsch.

This operating manual has been prepared to the best of our knowledge and checked for accuracy at the time of printing. FRITSCH GMBH assumes no guarantee or liability whatsoever for the accuracy or completeness of the contents of this operating manual, including but not limited to the implied warranties of merchantability and fitness for a particular purpose, unless liability is expressly prescribed by applicable laws or jurisprudence.

FRITSCH GMBH expressly reserves the right to modify and/or update this operating manual without prior notice. The same applies to modifications and improvements to the products described in this operating manual. It is the responsibility of the user to ensure that they have the current version of this operating manual. For more information, please contact your local FRITSCH GMBH distributor or Fritsch GmbH, Industriestr. 8, D-55473 Idar-Oberstein.

Not all parts shown here are necessarily installed in the product. The buyer is not entitled to delivery of these parts. If interested, please contact your local FRITSCH GMBH distributor or Fritsch GmbH, Industriestr. 8, D-55743 Idar-Oberstein.

FRITSCH GMBH takes the greatest care to ensure that the quality, reliability and safety of your products are continuously improved and adapted to the state of the art. The supplied products as well as this operating manual conform to the current state of the art when they leave the sphere of influence of FRITSCH GMBH.

By using the product the customer agrees with this and recognizes that defects, malfunctions or errors cannot be completely excluded. To prevent risk of damage to persons or property or of other direct or indirect damage, resulting from this or other causes, the customer must implement sufficient and comprehensive safety measures for working with the product.

## Exclusion of liability

Fritsch GmbH excludes any liability, warranty, or other obligation to compensate for damages, regardless of whether this liability, warranty, or other obligation is explicit or implicit, contractual or arising from unlawful acts or prescribed contractually, by law, or otherwise. In no event shall the buyer be entitled to any compensation from Fritsch GmbH for any special, direct, indirect, coincidental or consequential damage, including but not limited to lost profits, lost savings, lost sales or financial loss of any kind or for compensation of third parties, for downtimes, for lost goodwill, for damage to or replacement of equipment and property, for costs or restoration of materials or goods related to the product or the use of our products, for other damage or injury to persons (including fatal injuries) or similar. The above exclusion of liability is limited by mandatory liability as prescribed by laws or jurisprudence. Liability for negligence is excluded in all cases.

No permission is given expressly, implicitly or otherwise for the use of patents, brands or other copyrights. We also assume no liability for copyright infringements or infringements of the rights of third parties arising from the use of this product.

Neither compliance with this operating manual nor the conditions and methods used during installation, operation, use and maintenance of the product can be monitored by Fritsch GmbH. Improper execution of the installation can result in property damage and thus endanger persons. Therefore, we assume absolutely no responsibility or liability for loss, damage or costs that result from errors at installation, improper operation or improper use or improper maintenance or are in any way connected to these.

## Safety logbook

### 15 Safety logbook

Date	Maintenance / Repair	Name	Signature



## Safety logbook

Date	Maintenance / Repair	Name	Signature

## Index

### 16 Index

<b>A</b>		
Accident prevention . . . . .	8	
Additional clamping system . . . . .	39	
Ambient conditions . . . . .	21	
Authorised persons . . . . .	8	
<b>C</b>		
Cleaning grinding elements . . . . .	45	
Cleaning the mill . . . . .	45	
Cleaning the valves . . . . .	43	
Conducting a grinding operation . . . . .	37	
Cooling the grinding bowl . . . . .	38	
<b>D</b>		
Dimensions . . . . .	16	
Disposal . . . . .	51	
Dry grinding . . . . .	30	
<b>E</b>		
Electrical connection . . . . .	21	
Electrical safety . . . . .	15, 16	
Examples of comminution tasks . . . . .	49	
Exclusion of liability . . . . .	54	
Explanation of signs . . . . .	10	
Explanation of symbols . . . . .	10	
<b>F</b>		
Filling grinding bowls . . . . .	29	
Filling quantities of the grinding bowls . . . . .	28	
Final fineness . . . . .	17	
<b>G</b>		
Grinding duration . . . . .	35	
Grinding in inert gas . . . . .	41	
GTM - system . . . . .	44	
Guarantee terms . . . . .	52	
<b>I</b>		
Initial start-up . . . . .	23	
Installing valve inserts . . . . .	44	
<b>M</b>		
Maintenance . . . . .	46	
Materials . . . . .	17	
<b>N</b>		
Number of balls per bowl . . . . .	27	
<b>O</b>		
Operating noise . . . . .	16	
Overload . . . . .	37	
Overload protection . . . . .	15	
<b>P</b>		
Power consumption . . . . .	16	
Preparing gassing . . . . .	42	
Protection against restart . . . . .	15	
Protective equipment . . . . .	14	
<b>R</b>		
Reparatur . . . . .	47	
Requirements for the user . . . . .	8	
Reverse mode . . . . .	30	
Running time . . . . .	29	
<b>S</b>		
Safety information . . . . .	10	
Safety logbook . . . . .	56, 57	
Selecting the grinding balls . . . . .	24	
Selecting the grinding bowl . . . . .	24	
Setting up . . . . .	19	
Size of the grinding balls . . . . .	26	
Skilled workers . . . . .	8	
Speed . . . . .	29	
<b>U</b>		
Unpacking . . . . .	18	
<b>V</b>		
Ventilating after grinding . . . . .	43	
Voltage . . . . .	16	
<b>W</b>		
Warning information . . . . .	10	
WEEE . . . . .	51	
Weight . . . . .	16	
Wet grinding . . . . .	31	



© 2014

Fritsch GmbH

Milling and Sizing

Industriestraße 8

D - 55743 Idar-Oberstein

Telephone: +49 (0)6784/ 70-0

Fax: +49 (0)6784/ 70-11

Email: [info@fritsch.de](mailto:info@fritsch.de)

Internet: [www.fritsch.de](http://www.fritsch.de)

---